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ISO 14001 certification and financial performance: selection-effect versus treatment-effect

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ABSTRACT

The paper explores the bi-directional relationship between ISO 14001 certification and financial performance with the aim of shedding light on whether better performance is due to the beneficial effects of ISO 14001 or due to selection-effects where better performance precedes accreditation. The study uses a five year longitudinal analysis to compare the financial performance of firms in Spain before and after certification. The results of a multivariate panel data analysis find that firms with better than average performance have a greater propensity to pursue accreditation but there is no evidence that improvements in performance follow certification. This suggests that the inference that environmental variables cause improved financial performance may be unwise in research studies that can only measure association.

1. Introduction

Commitment to the natural environment has become an important variable within current competitive scenarios (Graff, 1997). "Business-led" initiatives such as development of firm-structured environmental management systems (EMSs), participation in trade association programmes emphasizing codes of environmental management, and adoption of international certification standards for environmental management are becoming widespread (Anton et al., 2004; Nakamura et al., 2001). This is illustrated by registrations to the ISO 14001 EMS standard which have grown nearly 50% in recent years with 188,815 firms in 155 countries registered at the end of 2009 (ISO, 2009). This suggests that there is a widespread belief in the international business community of the benefits of ISO 14001 registration.

Although there is a plethora of research articles that study ISO 14001 EMS standard and their association with environmental performance improvement (Dahlström and Skea, 2002; Florida and Davidson, 2001; King and Lenox, 2002; King et al., 2005; NDEMS, 2003; Potoski and Prakash, 2005; Russo and Harrison, 2001; Szymanski and Tiwari, 2004; Schaltegger and Synnestvedt, 2002), there are few articles that examine the relationship between ISO 14001 and financial performance, and there is little of this research that can attribute causality. The inference often drawn is that ISO accreditation leads to higher levels of performance. What tends to be forgotten is that the opposite direction of causality could be true, i.e., successful firms may well have a propensity to pursue certification. Thus, environmental performance and/or its accreditation could be a kind of 'luxury good' for a company when it has reached a certain level of economic performance (Schaltegger and Synnestvedt, 2002). In other words, financial performance may influence environmental management (Wagner, 2005) because a firm with a good financial performance can allocate more resources to environmental initiatives. Moreover, it must be taken into account, as has been stressed by other authors (King et al., 2005; Potoski and Prakash, 2005), ISO 14001 accreditation is often market driven, adopted because customers require it, or because competitors have it.

Therefore, the aim of this article is to examine the relationship between ISO 14001 and financial performance with a particular emphasis on trying to establish the direction of causality in that relationship. To achieve this we compare the actual sales and profitability of ISO 14001 accredited firms with their performance prior to registration.

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Furthermore, most quantitative studies are based on surveys in which the ratings were given by respondents that had taken part in the EMS introduction process (e.g. Sulaiman et al., 2002; Hamschmidt and Dyllick, 2001; Summers, 2002; Schylander and Martinuzzi, 2007). Any analyses of the effect of EMSs conducted in this way are subject to possible weakness and methodological distortion, so to avoid this problem we use only objective variables in our analyses.

The paper is structured as follows. First, we present a review of literature that considers environmental management, certification and performance. This is then followed by a description of our research methodology and presentation of our findings. These are then discussed and conclusions drawn.

2. Literature review

Some authors see corporate environmental strategy as a tool which may help organisations gain competitive advantage and improve performance levels (Hart, 1995; Porter and Van der Linde, 1995; Shrivastava, 1995; Trung and Kumar, 2005). Specifically, through environmental management, firms may reduce costs and increase revenues (Ambec and Lanoie, 2008). Others, however, have questioned the optimism of environmental advocates (Jaffe et al., 1995; Walley and Whitehead, 1994), emphasizing that environmental practices and initiatives involve costs and may have few financial benefits.

In order to explore these arguments a computer search of the ABI Inform, Emerald and Science Direct databases was made for works that cited the expressions environmental management, ISO 14000, ISO 14001, performance, results or profitability in the title of the paper. The list of references given in seminal papers was also reviewed. We excluded the many articles that are anecdotal, and the many case study based articles that could not provide quantifiable statistical evidence. Thus, we focus our review on the growing body of recent studies that have tested this linkage between environmental proactivity and a firms' performance using statistical analysis. We summarise these in Tables 1 and 2.

Although the findings are mixed, studies where a significant positive relationship between environment and firm performance is found are predominant. If we view changes in business performance as a treatment-effect of environmental proactivity, then clearly the overall conclusion from the research summarised in Tables 1 and 2 is that gains in business performance are a likely but uncertain effect as there are fourteen positive and six negative performance effects reported.

Looking at the detail it is worthy of note that earlier studies predominantly show a link between an environmental variable and improved financial performance and that Northern American studies tend to be dominant in these earlier years. However we believe geographic differences are not the underlying explanation, but the propensity of USA scholars to use quantitative methods compared to the European tendency to use qualitative approaches in new lines of research (which excludes early European studies from our tables).

Looking at the year of publication, it can be observed that studies published before 2000 report predominantly positive findings, while after 2000 the tables tend to show few performance improvements. Three possibilities for earlier adoption being linked to improved performance suggest themselves. Firstly, it may be due to the sales promotional benefits of being ahead of rivals in signalling good green credentials. Secondly, it may be that early initiatives have the advantage of greater returns on capital investment since firms start with improvements that offer the greatest return on green investment. Finally, the findings may be due to selection-effects where more profitable firms are more likely to pursue environmental improvements since they have the available funds to do so. The aim of our study is throw more light on this selection-effect possibility.

In the 25 studies we have just summarised there are only three that analyse the relationship between ISO 14001 certified firms and financial performance. Yet, studies that use registration to ISO 14001 as their environmental variable have the substantial advantage that the registration requires third party auditing of the firm's EMS as meeting the standard, thus avoiding the difficulties associated with judging the actual degree of environmental management undertaken in voluntary programmes. The advocates of ISO 14001 claim similar operational, managerial and competitive benefits for organisations as the advocates of the Porter Hypothesis (Porter and Van der Linde, 1995). These include reduced costs of waste management, savings in the consumption of energy and materials, an enhanced corporate image, regulatory cost savings, and improved customer and other stakeholder relationships. Furthermore, those authors who have analysed the content, scope and depth of the ISO 14001 standard have highlighted the potential positive impact of introducing the standard in reducing costs and in improving the economic and financial performance of the firms involved (Cascio, 1996; Marcus and Willig, 1997; Sheldon, 1997; Woodside, 2000; Cheremisinoff and Bendavid-Val, 2001; Morris, 2003).

However, although there are many academic studies that have analysed the motivation for and positive benefits that might result from accreditation to the ISO 14001 standard (e.g. Van Der Veldt, 1997; Sulaiman et al., 2002; Hamschmidt and Dyllick, 2001; Summers, 2002; Morrow and Rondinelli, 2002; Schylander and Martinuzzi, 2007; Fryxell and Szeto, 2002; Klassen and McLaughlin, 1996; Gavronski et al., 2008; Poksinska et al., 2003; Rondinelli and Vastag, 2000; Zutshi and Sohal, 2004, 2005) these tend to be small scale studies or based on surveys using personal ratings for performance improvement by managers who themselves have taken part in the EMS introduction process. This self-reporting introduces the potential for a bias problem that several authors have commented on; among others, Huber and Power (1985) and Podsakoff and Organ (1986) for the general management field, Safizadeh and Ritzman (1997) for the operations management field, Wayhan et al. (2002), Wayhan and Balderson (2007) and Heras et al. (2002) for the case of Quality Management systems, and Nawrocka and Parker (2009) in the case of EMS. These authors underline that performance variables based on perceptual measures of managers, can be biased due to the person providing the information having a personal interest in overvaluing it. Thus, in our research we follow the advice of these authors who suggest that for financial variables it is desirable to use objective data on firms from existing records such as commercial databases containing economic and financial information. However, we acknowledge as Ketokivi and Schroeder (2004) state, that it is the predominant use of single-informant, not the fact that the measures are perceptual, that underlies the problem of inflationary bias in the use of single-informant surveys.

At the time of writing there are few studies that combine the desirable properties we seek of objective financial performance variables and the ISO 14001 EMS accreditation variable. Watson et al. (2004) analyse how the ratios of ROA, business margins and other similar ratios varied in the case of those companies that had introduced a certified EMS and companies that had not, finding that there were no significant differences between them across different economic sectors. Similar lack of proof of performance change is reported by Cañón and Garcés (2006) who assessed the economic impact of ISO 14001 certification by studying whether the announcement of ISO 14001 certification by 80 large Spanish companies was interpreted by the stock market as a sign of environmental pro-activity that would generate

Table 1
Summary of studies linking environmental variables to improved financial performance.

Study	Sample	Environmental variables	Financial performance variables	Main analysis	Major findings
Cohen et al. (1995)	S&P 500 US firms with environmental data available	TRI emissions, oil spills, chemical spills, environmental litigation cases	ROA, return on equity (ROE), total return to common shareholders (Compustat)	Groups, *t*-test	The group of low-polluting firms had better economic performance (not always at a significant level).
Hart and Ahuja (1996)	127 US firms in SIC listed in S&P 500	Emission reductions based on TRI from the IRRC Corporate Environmental Profile data	ROA, ROE, return on sales (ROS) (Compustat)	Regression analysis	Pollution prevention activities have a positive influence on financial performance within 1–2 years. ROE takes longer to be affected.
Klassen and McLaughlin (1996)	US firms with environmental awards and crises	Environmental awards in the NEXIS database; chemical/oil spills, gas leaks or explosions	Stock market returns (NYSE, AMEX, CRSP)	Event study	Environmental awards (crises) led to significant, positive (negative) changes in market valuation.
Russo and Fouts (1997)	243 US firms (several sectors)	Environmental ratings (FRDC): compliance, expenditures, waste reduction	ROA	Regression analysis	Positive and significant impact of environmental performance on ROA.
Judge and Douglas (1998)	196 US firms (World Environmental Directory)	Integration of environmental issues into the strategic planning process (perceptual measures)	ROI, earnings growth, sales growth, market share change (percept. measures)	Structural equation model	Positive and significant impact of environmental issue integration on financial performance.
Sharma and Vredenburg (1998)	99 Canadian firms (oil and gas)	Proactive environmental strategy (perceptual measures)	Organisational benefits (perceptual measures)	Regression analysis	Positive and significant influence of proactive practices on organisational capabilities and of the latter on organisational benefits.
Edwards (1998)	51 environmental leaders in 8 UK sectors	Assessment of aspects of each firm's environmental performance. and management	Return on capital employed (ROCE), ROE	Groups	In several comparisons, environmental high-performing firms perform better.
Klassen and McLaughlin (1996)	69 US firms in the furniture industry	Environmental technology portfolio	Manufacturing performance measures	Regression analysis	Positive and significant impact of environmental technology portfolio on manufacturing performance.
Christmann (2000)	88 US chemical companies	Envir. Management "best practices": use of pollution prevention technology (PPT)	Cost advantage (perceptual measures)	Regression analysis	Positive and significant effect of proprietary PPT innovation.
De Burgos and Céspedes (2001)	Data by Judge and Douglas (1998)	Data by Judge and Douglas (1998)	Data by Judge and Douglas (1998)	Data by Judge and Douglas (1998)	Positive impact of environmental issue integration on financial performance.
King and Lenox (2002)	614 US manufacturing firms (Compustat and TRI)	Total emissions, pollution reduction means or methods (waste generation, waste prevention, waste treatment, waste transfer)	ROA, Tobin's q	Regression analysis	Lower emissions (in t) are significantly associated with higher financial performance (in $t+1$). Significant and positive relationship of waste prevention with ROA and Tobin's q.
Melnyk et al. (2003)	1222 manufacturing firm managers	State of the EMS	Ten corporate performance perceptual measures	Regression analysis	Positive and significant impact of EMS state on the ten corporate performance measures.
Al-Tuwaijri et al. (2004)	198 firms included in the IRRC Environmental Profiles Directory	Ratio of toxic waste recycled to total toxic waste generated	Stock price	Simultaneous equation model	Significantly positive relation between environmental and economic performance.
Wahba (2008)	156 Egyptian firms in several sectors (84 certified)	ISO 14001 certification	Tobin's q ratio	Correlation and regression analysis	ISO 14001 exert a positive and significant impact on the firm market value measured by Tobin's q ratio

Summary compiled by the authors. Full citations for the studies' authors can be found in the references.

Table 2
Summary of studies linking environmental variables to negative financial performance or showing no proof of improvement.

Study	Sample	Environmental variables	Financial performance variables	Main analysis	Major findings
Hamilton (1995)	463 US firms	TRI (Toxic Release Inventory) emissions	Returns (stock price reaction)	Event study	Significant negative returns on the day TRI emissions data were first announced.
Cordeiro and Sarkis (1997)	523 US firms in SIC codes 2000–3999	TRI releases that are recovered, treated or recycled on-site	Industry analyst earnings-per-share growth forecasts	Regression analysis	High environmental performance is significantly negative in relation to earnings-per-share growth forecasts.
Khanna and Damon (1999)	123 US firms in the chemical industry	EPA's Voluntary 33/50 Program (emissions of toxic chemicals)	ROI	Regression analysis	Statistically significant negative impact on the current ROI.
Gilley et al. (2000)	71 announcements of corporate environmental initiatives	Two types of environmental. initiatives: 39 process-driven and 32 product-driven	Anticipated firm performance (stock returns)	Event study	No significant effect of greening on performance. Different types of environmental initiatives have unique implications.
Wagner et al. (2002)	37 firms in the European paper industry (Germany, Italy, UK, Holland)	Environmental index integrating SO_2 emissions, NO_x emissions and COD emissions	ROS, ROE and ROCE	Simultaneous equation system	Negative and significant effect of environmental performance on ROCE. No evidence of significant impact of any economic performance variable on environmental performance.
Watson et al. (2004)	Companies with Corporate Self-Greenewal approach ten with EMS vs. ten no EMS.	EMS adoption	ROA, profit margin and other measures	Wilcoxon signed-rank test	Results do not show any significant difference in financial performance between EMS adopters and non-EMS adopters.
González-Benito and González-Benito (2005)	186 Spanish firms (chemical sector 63) (electronic-electric, 96) (furniture, 27)	27 environmental management practices	ROA (objective)	Regression analysis	Environmental management can bring about competitive opportunities for companies. Some environmental practices produce negative effects.
Menguc and Ozanne (2005)	140 Australian manufacturing firms	Higher order construct of natural environment orientation (NEO)	Market share; sales growth, profit over 2 years (objective performance measures).	Path analysis	NEO is positively and significantly related to profit after tax and market share but is negatively related to sales growth.
Wagner (2005)	Firms from four European countries in the pulp and paper-manufacturing sector	Input-oriented index (energy and water input) and output-oriented index (SO_2 NO_x and COD emissions) of environmental performance.	ROCE, ROE and ROS	Regression analysis	A largely negative relationship between the output-based index of environmental performance and financial performance. For the input-based index, the relationship is generally non-significant.
Cañón and Garcés (2006)	80 ISO 14001 certified plants of 34 Spanish firms =	ISO 14001 certification	Stock price	Event study	Negative impact of certification on pioneer, middle-polluting and lower size firms.
Link and Naveh (2006)	77 ISO 14001 certified organisations in Israel	ISO 14001 rules, policies and procedures. Emission of pollutions, use of recycled materials and other environmental aspects	Gross profit margin	Regression analysis	The higher the standardisation, the better the environmental performance. Environmental performance does not influence business performance.

Summary compiled by the authors. Full citations for the studies' authors can be found in the references.

market expectations of improved efficiency leading to improved market values (Hart, 1995).

There remains one more aspect that we need to discuss; the literature we have explored is dominated by studies that imply forward causation (a treatment-effect) between environmental proactivity and changes in performance but what is rarely discussed is the possible influence of reverse causation – a selection-effect mechanism see Dick et al. (2008). Therefore, caution is needed in inferring a positive direction of causation as the possibility of reverse attribution also exists, where better performance precedes the initiative and, if not controlled for, can be incorrectly attributed to the initiative.

The issue of whether "it pays to be good" (there are treatment-effects) or only the financially successful can "afford to be good" (there are selection-effects) is one of the oldest in the social responsibility literature. Taking into account that environmental management is part of social responsibility, the research examining the relationship between social performance and financial performance may provide interesting insights. Hence, we explore this literature so as to combine ideas from corporate social responsibility and environmental management.

Various arguments have been made regarding the relationship between firms' social responsibility and their financial performance (Barnett and Salomon, 2006; Brammer and Millington, 2008; Margolis et al., 1997; Margolis and Walsh, 2003; McGuire et al., 1988; McWilliams and Siegel, 2000; Walsh et al., 2003; Peloza, 2009; Godfrey et al., 2009; Hull and Rothenberg, 2008; Preston and O'Bannon, 1997; Ullmann, 1985; Griffin and Mahon, 1997; Orlitzky et al., 2003). One view is that firms face a trade-off between social responsibility and financial performance.

From the environmental management point of view, some authors also emphasize this trade-off, pointing out that an improvement in the environmental impact caused by an enterprise leads to a reduction in its profitability. It is suggested that compliance with environmental regulations incurs significant costs, reducing the capacity to compete (Jaffe et al., 1995). Furthermore, although cost savings can easily be obtained with a number of simple measures, the most ambitious prevention measures may involve costs that exceed the savings to be derived from them (Walley and Whitehead, 1994). Those suggesting a negative relationship between environmental management and financial performance argue that firms trying to enhance environmental performance draw resources and management effort away from core areas of the business, resulting in lower profits. In this view, managers cannot make both environmental and competitive improvements (Klassen and McLaughlin, 1996; Hull and Rothenberg, 2008). Agency perspectives on corporate social and environmental performance argue that when strong control from shareholders is absent, managers can opportunistically use corporate resources to pursue goals that enhance their own utility in ways that are unlikely to provide significant returns to companies. Consequently, good social and environmental performance come at the expense of good financial performance because social and environmental performance make use of firm resources in ways that confer significant managerial benefits rather than devoting those resources to alternative investment projects or returning them to shareholders.

In this paper, we focus on two alternative perspectives with regard to the relationship between social performance and financial performance. Along with the trade-off hypothesis, another view indicates that adherents of the stakeholder theory (Clarkson, 1995; Jones, 1995) appear to believe that favourable social performance (meeting the needs of various corporate stakeholders) will ultimately lead to favourable financial performance, and failure to meet the expectations of various non shareholder constituencies will generate market fears which in turn will increase a company's risk premium and ultimately result in higher costs and lost profit opportunities. Moreover, within this stakeholder theory the difference between the social and economic goals of a corporation is no longer relevant, because the central issue is the survival of the corporation, and this survival is affected not only by shareholders, but also various other stakeholders such as employees, governments and customers (Lee, 2008). Thus, the improvement of stakeholder relationships may prevent costly stakeholder conflicts (Hull and Rothenberg, 2008). Stakeholder and institutional theories share a conceptualization of organisations being embedded within a wider social system that shapes their behaviour. An organization's relationships with institutions and stakeholders are assumed to play a significant role in both the definition and determination of success (Donaldson and Preston, 1995). Effective management of relationships with key stakeholders can contribute to enhanced financial performance through the creation, development, or maintenance of ties that provide important resources to companies (Jones, 1995; Brammer and Millington, 2008). This "social impact" version of the stakeholder theory implies a causal relationship from social to financial performance: external reputation develops first, then financial results follow (Preston and O'Bannon, 1997).

If we focus on the influence exerted by improved environmental management (acknowledged through ISO 14001 accreditation) on financial performance, this influence may result in positive impacts on a firm's costs and market differentiation. Preventing pollution through implementation of ISO 14001 may enable the firm to save control costs, input, and energy consumption, and to reuse materials through recycling (Hart, 1997; Taylor, 1992). The generation of pollution is thus regarded as a sign of inefficiency (Porter and Van der Linde, 1995; Schmidheiny, 1992; Starik and Marcus, 2000) and environmental improvement as resource productivity utilising the opportunity costs of pollution (wasted resources, wasted effort, and diminished product value to the customer).

As for differentiation, reducing pollution may also result in increased demand from environmentally sensitive consumers, because the ecological characteristics of products are likely to be appreciated by these 'green' customers (Elkington, 1994). Moreover, a firm that shows good environmental initiatives will most probably acquire a high ecological reputation (Miles and Covin, 2000). Firms that adopt proactive environmental strategies may benefit from premium pricing and increased sales because of enhanced market legitimacy and greater social approval. Such approval may allow environmentally conscious organisations to market their management procedures as selling points for their products, and create a means to differentiate their products from their competitors (Rivera et al., 2000).

Therefore, environmental management can provide opportunities to reduce costs and increase revenues. Ambec and Lanoie (2008) point out that there are four opportunities companies can make use to reduce costs (risk management and relations with external stakeholders; cost of material, energy, and services; cost of capital; and cost of labor) and three opportunities to increase revenues (better access to certain markets; differentiating products; and selling pollution-control technology). Moreover, these authors indicated when it pays to be green, pointing out circumstances making opportunities for reducing costs and for increasing revenues more likely. For example, opportunities for reducing costs through risk management and relations with external stakeholders are more likely in industries that are highly regulated and scrutinized by the public, such as chemical, energy, pulp and paper, metallurgy, etc.; opportunities for reducing costs of materials, energy and services are more likely when firms have a flexible production process or when firms are in highly competitive industries where optimization of resources is important; opportunities for increasing revenues through a better access to certain

markets are more likely for firms selling to the public sector (construction, energy, transportation equipment, medical products or office equipment); and opportunities for increasing revenues differentiating products are more likely when there is credible information about the environmental features of the product, willingness-to-pay by consumers, and barriers to imitation.

Another possibility is that the causal relationship is from financial to social performance. Although firms may wish to follow the normative rules of good corporate citizenship, their actual behaviour may depend on the resources available. Hence, profitability in one time period may increase a firm's ability to fund discretionary projects, including social performance projects, subsequently. Policies and expenditures, particularly in discretionary areas such as social programmes, may be especially sensitive to the existence of slack resources (i.e., previous profits) (McGuire et al., 1988; Preston and O'Bannon, 1997). If corporate social responsibility is viewed as a significant cost, firms with relatively high past financial performance may be more willing to absorb these costs in the future (Brammer and Millington, 2008; Ullmann, 1985; Devinney, 2009).

In the environmental field, Wagner et al. (2002) pointed out that financial performance may influence environmental management. Thus, a firm with a good financial performance can allocate more resources to prevention-oriented technologies and initiatives. Nakao et al. (2007) obtained that a firm's financial performance has a positive impact on its environmental performance. Toffel (2006) explicitly set out in his research to find whether there is a positive *ex-ante* selection-effect on companies that decide to become certified to ISO 14001 (positive selection-effect). He finds that ISO 14001 registration has attracted companies with better environmental performance or results – measured in terms of base TRI emissions. In short, he proves the existence of a selection-effect.

Unlike Toffel (2006), who focuses mainly on the relationship between ISO 14001 and environmental performance, our study focuses on the linkage between ISO 14001 and financial performance. Other authors who accept the need to control for selection-effects have used methodologies to control for its influence (Corbett et al., 2005; Naveh and Marcus, 2005; Terlaak and King, 2006). However, we believe like Toffel (2006) that it is advantageous to report on the performance that can be attributed to the ISO 14001 EMS effect and the proportion that may be due to better than average prior performance. Thus, we will be attempting to test whether there exists an *ex-ante* selection mechanism where better performing firms have a greater propensity to become certified, a positive selection-effect, and whether there is an *ex-post* improvement effect on financial performance due to the treatment that certification entails (treatment-effect).

Based on the literature we have reviewed and on the theoretical contributions that we have synthesized we derive two hypotheses that we will test on our longitudinal data whose source we detail in Section 3.

Hypothesis A:. *companies will benefit from a treatment-effect after accreditation to ISO 14001 where sustainable improvements to sales volume and return on assets (ROA) are achieved compared to their levels prior to accreditation (not-yet-certified firms will improve their sales volume and ROA after becoming certified compared to non-certified firms).*

Hypothesis B:. *There is a selection-effect where companies that intend to pursue ISO 14001 certification have higher returns on assets (ROA) and greater sales volume growth than similar companies who do not intend to adopt certification. (Not-yet-certified companies will have higher ROA's and greater sales growth than non-certified firms.)*

3. Methodology

3.1. Sample and data collection

The data analysed in this paper covers a six-year time period and analyses the comparative financial performance of ISO 14001 certified firms before and after certification compared to a control group of firms without certification.

The research was undertaken in the Basque Autonomous region, which is known to be one of the regions in Spain where ISO 14001 registrations are concentrated (Heras et al., 2008). The ISO 14001 certification data was gathered from the Catálogo Industrial Vasco y de Exportadores de 2006, the database of certified firms of the Basque Government that is maintained by Ihobe, the publicly owned Basque Agency of Environmental Managemevnt. Our financial performance data was gathered from the SABI[3] database that is one of the most complete for Spanish firms' economic and financial information. Altogether we have access to performance information from 268 ISO 14001 certified companies that we will be contrasting with performance information from the 7232 companies that are not-certified. The resulting financial data set was analysed to identify outliers and these were removed so that data fitted a normal distribution.

3.2. Variables

Data was available for the years 2000–2005, and included the sales revenue for each accounting year, as well as the profitability ratio (ROA, the ratio of net profit before interest and tax on total assets). In addition, for the certified companies, the data set included information on their last certification registration date. This information on registration dates was checked with the registration bodies and where necessary with the companies to ensure that the date we recorded was the true date of the firm's initial registration to ISO 14001. Although, the sample distributions of the ISO 14001 certified companies were not balanced across the sectors (manufacturing, construction, trade and services) their profile was similar to that previously reported for the total population of certified companies (Heras et al., 2008) so we are confident that they are representative of the population as a whole.

Possible sources of bias in the two samples were checked. Firstly, we noted that the two samples were not homogenous. ISO 14001 certified firms had on average larger sales turnovers and number of employees than non-certified firms did, which is also true for the total population of certified companies in the Basque Autonomous Community (Heras et al., 2008). To test that any difference in profitability of the certified companies is not a direct result of their larger sales we used the Wilcoxon–Mann–Whitney test, with a level of significance set at 0.05, as well as a t-test for differences in means. Both these calculations indicate that there was no statistically significant effect of turnover on ROA. This is confirmed by the correlation coefficient between firms' sales revenue and the ROA. Likewise, to see if industry selection-effects existed for ISO 14001 the average profitability ratio for all the sectors (manufacturing, construction, trade and services) for all years was calculated to establish if there were any sector differences between the certified sample and control that were creating a bias in the results. No statistically significant differences were identified using the Wilcoxon–Mann–Whitney test (level of significance set at 0.05). Therefore, we may be confident that any differences found between ISO 14001 certified and non-certified

[3] SABI (*Sistema Anual de Balances Ibéricos*) data elaborated by Bureau Van Dick.

Table 3
Descriptive statistics.

	N	Mean	Std. deviation
Total firms			
Size[a]	7500	39,205	101,329
RO	7500	0.053	0.098
Sales growth	7500	0.094	0.089
Non-certified			
Size[a]	7232	28,867	47,839
ROA	7232	0.043	0.098
Sales growth	7232	0.074	0.093
Certified			
Size[a]	268	188,083	319,486
ROA	268	0.056	0.089
Sales growth	268	0.087	0.091

[a] Average of number of employees at the end of 2005.

companies are not related to the firms' size or sector distribution of the two samples.

In the study we use the registration year to split the not-yet-certified from the certified companies since we found no evidence of any increase in firms' performance in the one or two years prior to certification in our earlier work that used an event-study method on similar data concerning quality control system certification to ISO 9001 (Heras et al., 2002). In summary, the research design consists of three samples of firms: certified, not-yet-certified and non-certified for each of the six years, and two variables, sales growth, and return on total assets employed (ROA).

4. Results

4.1. Testing for treatment-effect and selection-effect

We start by presenting the findings of our longitudinal study using a treatment-effect assumption i.e. where performance differences in return on assets employed (ROA) and sales growth between certified and non-certified firms are assumed to be due to adoption of an ISO 14001 EMS. These findings then provide a starting point that allows later comparison with the selection-effect results. For the treatment-effect results we use a dichotomous split between certified and non-certified firms (not-yet-certified firms being excluded from the analysis). The results for the two samples ROA over the years 2000–2005 are presented in Table 3. The findings indicate that certified firms achieved a better average ROA (5.91%) than non-certified firms (4.32%) during the six years, with three out of the six years being statistically significant.

Table 5
Average profitability (ROA) of ISO 14001 certified and non-certified companies.

	2000	2001	2002	2003	2004	2005	Period average
Certified (%)	7.80*	5.73	5.41	5.19	5.86**	6.11**	5.91*
Non-certified (%)	5.61	5.27	4.38	4.05	3.45	3.16	4.32

Source: Created by the authors. Note: Wilcoxon–Mann–Whitney test differences between certified and non-certified. $^{**}P < 0.01$; $^{*}P < 0.05$. ROA is defined as profit before tax as a proportion of total assets.

A similar picture emerges for sales growth (Table 4) with certified firms enjoying better average sales growth than non-certified firms over the six years with their average sales growth being 50.1% for certified firms compared to non-certified firms' 36.9%. Here, three out of the six years show statistically significant differences.

These sales and profitability results provide good evidence for sustainable improved performance being associated with accreditation to ISO 14001. However, all that we have actually found is an association betweens ISO 14001 accreditation and the improved performance. If the better performance found in Tables 1 and 2 is to be claimed for ISO 14001 it requires that we know that not-yet-certified firms have similar performance to non-certified firms. This will provide evidence that there are no selection-effects.

To see if these implications are valid we now examine the same data set but include in our findings the results for not-yet-certified firms. These are firms that do not have certification in the beginning of the year that is mentioned in the column (all the certification data is by 12/31 of each year), but will be certified before the 31st of December 2005, which is the end year of our longitudinal analysis.

The findings for profitability of the not-yet-certified firms are shown in Table 5; alongside the ROA are the significance level results for tests of difference compared to the control group of non-certified firms. Overall, the period average ROA for the years 2000–2005 is significantly better for certified (5.56%) and not-yet-certified (6.17%) than non-certified firms (4.32%). The better performance of not-yet-certified (6.17%) than certified firms (5.56%) shows that it is selection-effects not treatment-effects that are the most likely cause of the better returns found in the certified firms. Thus, the findings show that firms had greater ROA than their peers before certification but show no additional profitability gains from it (given that the tests for company size bias and industrial sector differences showed that these were not an influence).

The findings for year-on-year per cent sales growth are shown in Table 6. Overall sales growth is significantly better for certified (43.5%) and not-yet-certified (61.1%) than non-certified firms

Table 4
Correlation coefficients of the variables.

	Cert								Sales 2000	Sales 2001	Sales 2002	Sales 2003	Sales 2004	Sales 2005
Size[a]	0.39**	Size							0.51**	0.26**	0.25**	0.31**	0.37**	0.34**
CNAE_1	−0.02	0.00	CNAE_1						0.06	0.11*	−0.02	0.03	0.03	−0.02
CNAE_2	0.02	0.07**	−0.08**	CNAE_2					−0.03	−0.02	−0.03	−0.10**	−0.11**	0.07**
CNAE_3	0.00	−0.04	−0.02	−0.54**	CNAE_3				−0.03	−0.02	−0.13**	−0.03	0.07**	0.03
CNAE_4	−0.03	−0.03	−0.02	−0.37**	−0.11**	CNAE_4			0.02	0.03	−0.04	0.03	−0.02	−0.02
CNAE_5	0.00	−0.03	−0.02	−0.53**	−0.17**	−0.11**	CNAE_5		−0.04	0.02	−0.03	0.02	0.02	−0.03
CNAE_6	0.00	−0.02	0.00	−0.10**	−0.03	−0.02	−0.03	CNAE_6	−0.03	−0.02	0.02	−0.01	−0.04	0.02
ROA_2000	0.02*	0.00	−0.02	0.02	0.00	−0.02	0.00	−0.01	ROA 2000	0.01	−0.02	0.02	−0.02	−0.02
ROA_2001	0.01	−0.02	−0.01	−0.01	−0.02	0.00	0.03	−0.05*	0.40**	ROA 2001	−0.01	0.02	−0.01	0.02
ROA_2002	0.01	−0.02	−0.01	−0.03	0.03	0.01	0.01	−0.05*	0.28**	0.45**	ROA 2002	−0.01	0.03	−0.01
ROA_2003	0.03*	−0.01	0.02	−0.03	0.00	0.04	0.01	−0.03	0.21**	0.32**	0.44**	ROA 2003	0.02	−0.02
ROA_2004	0.03**	0.01	−0.01	−0.03	−0.01	0.02	0.02	0.04	0.21**	0.27**	0.31**	0.40**	ROA 2004	0.04
ROA_2005	0.04**	0.03	0.02	−0.03	0.00	0.03	0.01	−0.01	0.16**	0.20**	0.22**	0.28**	0.37**	ROA 2005

Source: Authors.
Note: Significance levels at 1%** and 5%*. CNAE 1–6 are, respectively, the industrial sectors CNAE_: 1 Farming and fishing; 2 Manufacturing; 3 Construction; 4 Trade, Hospitality and Transportation; 5 Banks and Insurance; and 6 other services.
[a] Number of employees at the end of 2005.

Table 6
Average sales growth of ISO 14001 certified and non-certified companies.

	2000 −1	2001 −2	2002 −3	2003 −4	2004 −5	Period cumulative
Certified (%)	13.35	8.60	7.30	10.5*	10.4*	50.1
Non-certified (%)	13.0	6.17	5.78	6.44	5.48	36.9

Source: Created by the authors. Note: Wilcoxon–Mann–Whitney test differences between certified and non-certified. $^{**}P < 0.01$; $^{*}P < 0.05$.

(36.9%). The better sales growth in not-yet-certified firms (61.1%) than certified firms (43.5%) shows that it is selection-effects rather than treatment-effects that are the most likely cause of the better returns found in certified firms. Thus, the findings show that firms had better sales growth prior to certification and show no additional sales growth after it (Table 7).

If we contrast these results with those in Tables 3 and 4 that use a treatment-effect assumption we see a very different interpretation of the better financial performance results of the ISO 14001 accredited firms. Consistently over the six years of the study it seems that there are selection-effects where firms with better than average profitability and sales growth become accredited to ISO 14001. After accreditation this better financial performance continues but is not significantly enhanced by any ISO 14001 treatment-effect (Table 8).

4.2. Multivariate analysis using a panel of matched firms

To ensure that the results provided above are robust and avoid potential bias, we now extend the preceding analysis by constructing a panel of samples matched by sector and size to enable a multivariate panel data analysis. This method reduces substantially the potential limitation of the endogenous nature of the explanatory variable used in the analysis above.

To construct matching samples it was necessary to identify first those firms that received the treatment (in our case achieve ISO 14001 registration). As we want to test the self-selection and treatment-effects in the same analysis we selected only the firms that achieved the ISO 14001 during the period 2001–2005 (almost equivalent to the not-yet-certified sample). Only 115 firms met this condition. The second step consisted of making a matched pair by picking a firm from amongst the firms that had not received the treatment before 2005. At this stage we encountered the problems of missing data. Seven of the 115 treatment firms had no data on sector or number of employees and another ten firms had no close match on sector and size.

After the matching process we had a sample of 196 firms, 98 of them gained ISO 14001 between 2001 and 2005 and the rest are matched firms that did not have ISO 14001 accreditation during this period. Both groups had the same number of each sector as follows: 67.4% in manufacturing firms, 14.3% in construction, 17.3% in services (retail, hospitality, transport, banks and insurance) and the remaining 1% in other sectors. The treatment group had an average of 119 employees and the comparison group 121. For all the cases the differences between pairs is no more than 20%. So, *a priori* the only difference between groups is the achievement of ISO 14001 accreditation.

Table 7
Average profitability (ROA) of ISO 14001 certified, not-yet-certified and non-certified companies.

	2000	2001	2002	2003	2004	2005	Period average
Certified (%)	5.64	6.02	5.51	4.28	5.88*	6.02**	5.56
Not-yet-certified (%)	7.28*	5.89	5.58	6.28*	6.46**	5.74	6.21*
Non-certified (%)	5.61	5.27	4.38	4.05	3.45	3.16	4.32

Source: Created by the authors. Note: Wilcoxon–Mann–Whitney test differences between certified and non-yet-certified compared to the non-certified. $^{**}P < 0.01$; $^{*}P < 0.05$.

Table 8
Average sales growth of ISO 14001 certified, not-yet certified and non-certified companies.

	2000 −1	2001 −2	2002 −3	2003 −4	2004 −5	Period cumulative
Certified (%)	11.1	8.61	5.05	9.56*	9.12*	43.5
Not-yet-certified (%)	14.1	7.84	9.65	12.8*	16.7*	61.1*
Non-certified (%)	13.0	6.17	5.78	6.44	5.48	36.9

Source: Created by the authors. Note: Wilcoxon–Mann–Whitney test differences between certified and non-yet-certified compared to the non-certified. $^{**}P < 0.01$; $^{*}P < 0.05$.

The data collection allows a multivariate panel data analysis,[4] of a balanced panel with 196 firms and 5 observations per firm, so 980 observations in total. Table 10 shows the results of using the estimating equations[5] below that are derived from previous literature (e.g. Vendrell-Herrero, 2008, p.137; González-Pernía et al., in press):

$$\text{ROA} = \beta_0 + \beta_1 \text{Cert}_{it} + \beta_2 y_{it} + \beta_3 y \times \text{Cert}_{it} + \beta_4 \ln(\text{sales})_{it} + \varepsilon_{it} \quad (1)$$

$$\ln(\text{sales}) = \alpha_0 + \alpha_1 \text{Cert}_{it} + \alpha_2 y_{it} + \alpha_3 y \times \text{Cert}_{it} + \varepsilon_{it} \quad (2)$$

In the equation Cert is a dummy variable taking a value of 1 if the firm achieved ISO 14001 in the year t, and 0 otherwise. The variable y is the year. It takes a value 0 for the year of certification and positive values in subsequent years, while before certification it takes negative values. For example in the case of non-certified firms it takes values −5 in year 2001 to −1 in year 2005. Columns 1 (assumes $\beta_4 = 0$), column 2 refer to Eq. (1) and column 3 refers to Eq. (2).

A benefit of this method of empirical analyses is that it allows estimating the self-selection and treatment-effects in the same regression equation. For example in Eq. (1), when $y = 0$ (the moment of certification), β_1 measures the difference in ROA at the moment of achieving the certification. So if β_1 is significantly positive it would mean that certified firms have a greater performance prior the certification and hence Hypothesis B (selection-effect) could be accepted. The treatment-effect comes into play after certifications ($y \times \text{Cert} > 0$) and its influence is indicated by the coefficient β_3 which measures the time trend of ROA difference. Hence if β_3 is significantly positive it would mean that Hypothesis A (treatment-effect) should be accepted.

Additionally, in all models we control for time and sector unobserved heterogeneity through the introduction of time and sector dummy variables. Because the assumption of independence and equal variance between the error terms will not hold if some firms systematically use unobserved inputs in excess of the average during certain periods, leading to potential misspecifications of coefficient values (Huber, 1967; White, 1982), from now on the estimations use only robust standard errors.

The results in Columns 1 and 2 of Table 9, show that β_1 is significantly positive showing Hypothesis A is accepted, while Hypothesis B is unsupported as we cannot reject that β_3 equals

[4] See Greene (2008, pp.557–589) for a detailed exposition of panel data models.
[5] For the purpose of regression analyses we transform sales into natural logarithms to correct for skewed distribution.

Table 9
Panel data analysis with matched samples.

		Eq. (1)		Eq. (2)
		Column1	Column2	Column3
		ROA		Ln(Sales)
HB Selection-effect	*Cert*	0.022** [β_1] (0.023)	0.021** [β_1] (0.027)	0.164 [α_1] (0.293)
	y	−0.002 (0.505)	−0.002 (0.410)	0.122** (0.037)
HA Treatment-effect	*y* × *Cert*	−0.003 [β_3] (0.659)	−0.003 [β_3] (0.636)	0.058 [α_3] (0.610)
	Ln (Sales)		0.004** [β_4] (0.029)	
	Intercept	0.054*** (0.000)	−0.009 (0.775)	15.63*** (0.000)
	Observations	980	980	980
	Firms	196	196	196
	R^2	0.025	0.031	0.128
	F	2.69***	2.66***	17.91***

Note: Level of statistical significance: *** 1%, ** 5%, * 10%. *P*-value in parenthesis. OLS Robust Estimations including sector's and year's dummies.

zero. Therefore, the results (Table 9, β_1) support the existence of a ROA selection-effect and show that certified firms are between 2.1% and 2.2% more profitability than non-certified firms at the moment of achieving the ISO 14001. On the other hand evidence for a treatment-effect is absent as Table 9 β_3 shows the treatment influence is 0.3% and statistically not significant.

According to the results of the analysis of sales in Column 3 of Table 9 α_3 is not significant. Therefore, no treatment-effect influence of ISO 14001 on sales volume is proven. It can be observed (Table 9 α_1) that with the same level of employees (samples are matched) certified firms have, on average sales that are 16% larger than non-certified firms at the moment of achieving the ISO 14001 but they are not statistically significant. This indicates that sales volume does not exert an influence on selection-effects showing that selection-effects are driven by profitable differences alone.

To test for causality we present results using the Granger criterion. Using the King and Lenox's (2002) approach we check the effect of certification when the lagged dependent variable is added to the model and control for unobserved firm effects. Since OLS estimates are not consistent when both fixed effects and lagged dependent variables are included, we estimate the model in first differences and use Y_{it-2} as a surrogate for ΔY_{it-1}. As before we perform the analysis on the matched samples of certified firms and the non-certified firms. However, in this analysis the number of observations is reduced to 588 as the specification requires only three periods of data. The results displayed in the first column in

Table 10
Panel data analysis with FE and lagged dependent variable.

	Eq. (1)			Eq. (2)	
ROA			Ln(Sales)		
	Coef.	Std. Err.		Coef.	Std. Err.
Cert($t-1$)	−0.02*	(0.01)	Cert($t-1$)	0.06	(0.05)
Cert	0.04**	(0.01)	Cert	−0.05	(0.06)
Cert($t+1$)	0.01	(0.01)	Cert($t+1$)	0.04	(0.06)
Ln(Sales)	0.04***	(0.01)	ROA	1.05***	(0.22)
Intercept	−0.51***	(0.12)	Intercept	15.01***	(0.03)
Year dummies	Yes		Year dummies	Yes	
N	588		*N*	588	
Firms	196		Firms	196	
R^2	0.0577		R^2	0.0825	
F	5.15		*F*	13.2***	

Robust standard errors clustered at the firm level shown in parentheses. Level of statistical significance: *** 1%, ** 5%, * 10%.

Table 11
Panel data analysis with post treatment and anticipatory effects.

	Eq. (1)			Eq. (2)	
ROA			Ln(Sales)		
	Coef.	Std. Err.		Coef.	Std. Err.
Cert	0.01	(0.01)	Cert	0.01	(0.03)
Ln(Sales)	0.06***	(0.01)	ROA	1.19***	(0.24)
ROA (lagged)	−0.05	(0.11)	Ln(Sales)(lagged)	−0.24***	(0.09)
Intercept	−0.01	(0.01)	Intercept	3.62***	(1.37)
Year dummies	Yes		Year dummies	Yes	
N	588		*N*	588	
Firms	196		Firms	196	
R^2	0.0853		R^2	0.0074	
F	8.34***		*F*	7.19***	

First differences of independent variables and the IV strategy using the 2 year lag as an instrument for the lagged dependent variable are used. Robust standard errors clustered at the firm level shown in parentheses. Level of statistical significance: *** 1%, ** 5%, * 10%.

Table 10 reject any significant effect of certification on ROA changes, which is also found for changes in sales that are shown in Column 2. Taken together, these results support the previous findings of insignificant treatment-effects.

Next to check whether certification benefits lag the accreditation date we use an alternative Granger causality specification (Angrist and Pischke, 2009) by including leads and lags of the ISO 14001 treatment-effect. The results in the first column in Table 11 support the existence of a positive effect of gaining ISO 14001 certification in the year of adoption, which turns out to be negative in the following year and confirms the limited improvement of certification on firms' profitability. The coefficient on future certification shows little anticipatory outperformance of non-yet certified firms and confirms the direction of causality expressed before. Looking at Table 11, Column 2 we do not find any significant lag-lead relationship when performing the equivalent regression for sales on certification and ROA.

5. Conclusions

5.1. Summary

Our findings of the dominance of a selection-effect over a treatment-effect in explaining the better than average profitability and sales growth of ISO 14001 certified firms has also been found in research looking at longitudinal analyses of performance achievements in firms who are pursuing ISO 9001 in the USA, Spain and Denmark—for a review see Dick et al. (2008).

Furthermore, as stated in the literature review section, our pioneering findings for the specific case of ISO 14001 are consistent with the findings of corporate responsibility research looking at the causal relationship between financial performance and corporate social responsibility. Preston and O'Bannon (1997) called this the "Available Funds Hypothesis" as the availability of slack funds enables a firm to pursue costly environmental or social activities. Thus, this relationship is consistent with our finding for the dominance of the selection-effects over treatment-effects where more profitable firms have a greater propensity to adopt international standards for EMS that less successful firms.

5.2. Theoretical and practical considerations

In the empirical literature that we reviewed earlier (Tables 1 and 2 provides a summary) we concluded that overall there was stronger evidence for a positive relationship between environmental management initiatives and firms' performance than for neutral or negative results but that earlier adopters appeared to

gain most from their initiatives. Generally the assumption made in this research is that environmental proactivity is an independent variable with performance benefits being the dependent variable. Our findings suggest that it may be equally valid to consider a counterintuitive causation path were pursuit of environmental initiatives such as adoption of ISO 14001 being dependent on a firm having better than average performance. We believe that co-causation models where selection and treatment-effects are considered deserve wider consideration in the development of explanatory models. We suggest that by adopting research designs that can explicitly measure both effects a broader understanding of the role of selection-effects can be established.

So, what is it that drives these selection-effects that we have found? The Available Funds Hypothesis (Preston and O'Bannon, 1997) explains that lack of funds can deselect those who cannot afford the costs involved, but what motivates firms that are more prosperous to use their available funds on accreditation to ISO 14001? A plausible explanation is the signalling or reputation motivation for the pursuit of ISO 14001 accreditation. Here the theory of decentralized institutions (King et al., 2005) and theory of cartels and clubs applied to voluntary programmes (Potoski and Prakash, 2005) could be used to explain the symbolic value of certification that attracts better performing firms.

For practitioners, our findings should give pause for thought. It is indeed tempting for managers to believe that ISO 14001 certification will lead to business benefits. After all firms that they would like to emulate in terms of performance often have it! This is then reinforced by the seemingly pervasive conviction (often quoted as supported by research) that an EMS certified to ISO 14001 standard will reduce cost and increase sales. However, our findings, and the parallel findings for ISO 9001 adoption (Heras et al., 2002), indicate that it might be a wise decision to only pursue accreditation if there is a demand from customers for it, since we have found no sales or profitability improvements after certification. However, our findings indicate that the money spent on certification has not adversely affected the profitability of firms. This does suggest that cost benefits arising from certification are on average sufficient to offset the investment. Therefore, we are not suggesting to practitioners that certification to ISO 14001 is a bad investment, rather that inflated expectations of financial performance improvement are likely to be unfounded.

5.3. Limitations and future work

Although we have used objective variables in our research which have the advantage of avoiding respondent bias, we accept that financial performance depends on many other variables than the existence of an ISO 14001 accredited EMS. Indeed these latent variables may themselves be the drivers influencing our variables. So it always remains a possibility that our accredited firms are different in other ways that could lead to a distortion in the absolute level of abnormal ROA and sales growth difference we report at the point of registration. However, the methods we have used control for a firm's size and economic sector differences and control for unobserved heterogeneity. Additionally, our study has used repeated measures so any distortions are consistent across the years so the year-by-year differences within the study can be viewed as reliable indicators of the influence of treatment-effects vs. selection-effects.

Although our research is based on data from Spain, we believe that the selection-effect is not just a national phenomenon as there are indications from the research of Toffel (2006) in the USA and Nishitani (2009) in Japan that this selection-effect for ISO 14001 is widespread. This is confirmed from the parallel field of ISO 9001 research where selection-effects are found in other parts of Europe and the USA (Dick et al., 2008). However, given that over 155 countries with varied cultural and economic regimes have firms registered to ISO 14001 standards we accept that this selection-effect may not be universal in scope.

We hope that others will join us to extend our research on treatment-effects vs. selection-effect into other countries where ISO 14001 accreditation has become popular so that the influence of the selection-effect can be better understood alongside a better understanding of the specific drivers that mediate treatment-effects and selection-effects. This echoes the suggestion of Nawrocka and Parker (2009), who stress the need to analyse in which specific circumstances the adoption of EMS effect performance, rather than whether they do so or not. This in turn could lead to the development of broader theory that will enrich our understanding of the complexity of attributing performance in environmental research.

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